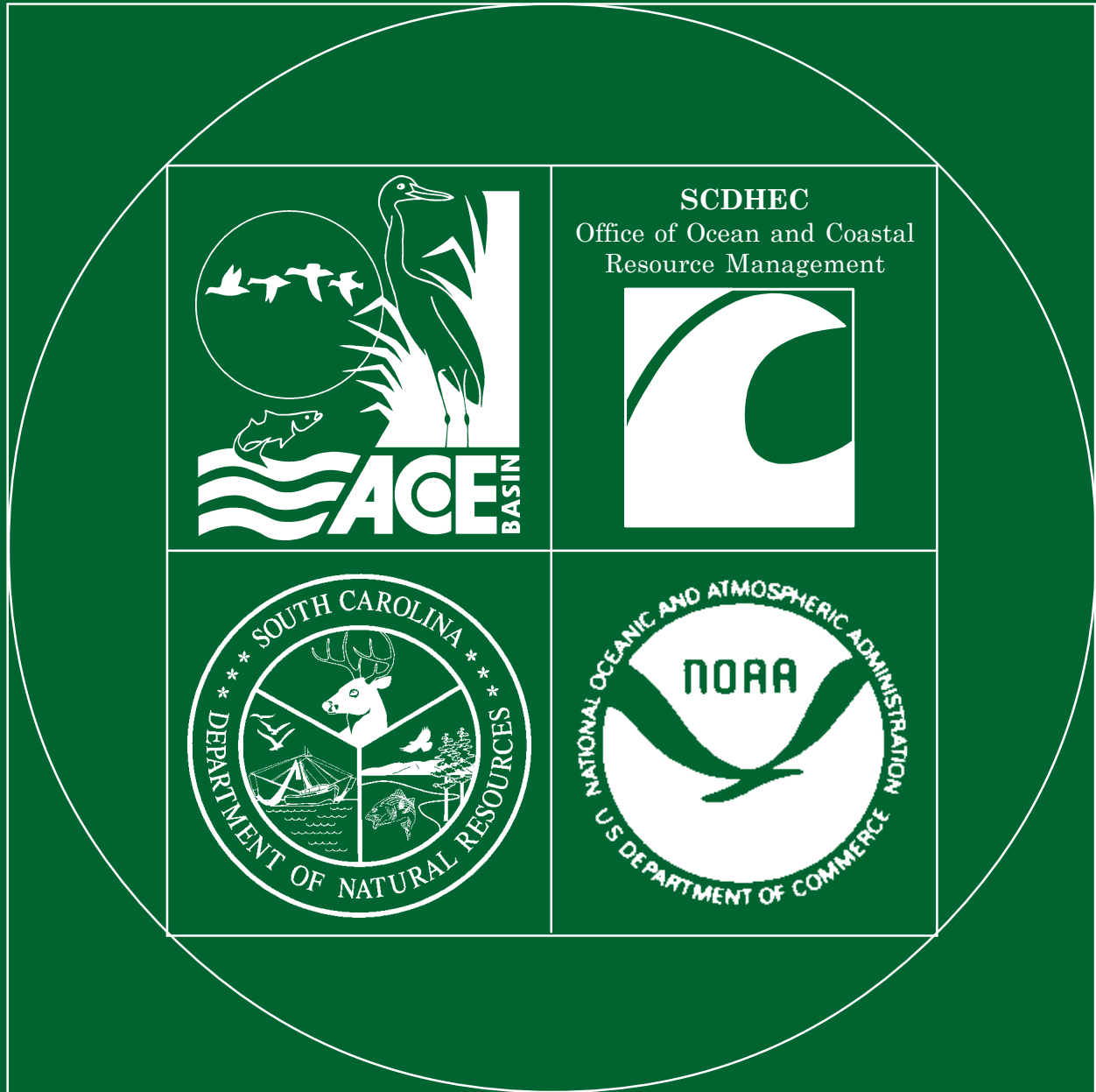


RESEARCH OPPORTUNITIES IN THE ACE BASIN NATIONAL ESTUARINE RESEARCH RESERVE



ACE Basin
National Estuarine Research Reserve
South Carolina Department of Natural Resources
217 Fort Johnson Road
Charleston, South Carolina 29422



The ACE Basin watershed served as a reservoir of nesting eagles when populations were at an all time low in the mid 1960's and contributed to the relatively rapid recovery of eagles in South Carolina.

EXECUTIVE SUMMARY

Prior to designation of the ACE Basin National Research Reserve in 1992, most of the research activities in the area were management-oriented projects that were primarily conducted by the South Carolina Department of Natural Resources (SCDNR). SCDNR performed annual surveys of estuarine fish and invertebrate species having recreational or commercial importance; game and non-game aquatic and terrestrial birds and mammals; threatened/endangered species; and natural plant communities. The data are used to determine the status of these populations, and the results were used to develop policies and management programs to maintain viable populations of the species.

Development and maintenance of a research program is a high priority of the Reserve. Because of its relatively low level of disturbance, the ACE has retained many of the attributes associated with estuaries at the turn of the century. This provides a benchmark against which to compare other coastal areas where significant human disturbances are occurring. The core area of the Reserve is well protected and serves as an undisturbed baseline monitoring area while the large and diverse buffer zone serves as an experimental research and demonstration area.

Over 25 research and monitoring projects have been conducted in or adjacent to the ACE Basin NERR, including water quality monitoring and vegetation analysis; studies on mammalian, reptilian, avian, fish, crustacean, and molluscan populations; a survey of sediment contaminants; the impact of marine structures on benthic communities; cumulative environmental impacts; and toxicology of fishes and oysters. The following agencies have funded projects in the Reserve: National Marine Fisheries Service, U.S. Geological Survey, National Oceanic and Atmospheric Administration/Sanctuaries and Reserves Division, NOAA Coastal Services Center, U.S. Environmental Protection Agency, U.S. Fish & Wildlife Service, U.S. Army Corps of Engineers, S.C. Sea Grant Consortium, S.C. Department of Health and Environmental Control and the S.C. Department of Natural Resources, as well as private corporations.

Research that relates directly to the management of the Reserve's resources will be actively encouraged and receive highest priority. Other research topics that address coastal management issues identified as having local, regional or national significance will also be considered.

INTRODUCTION

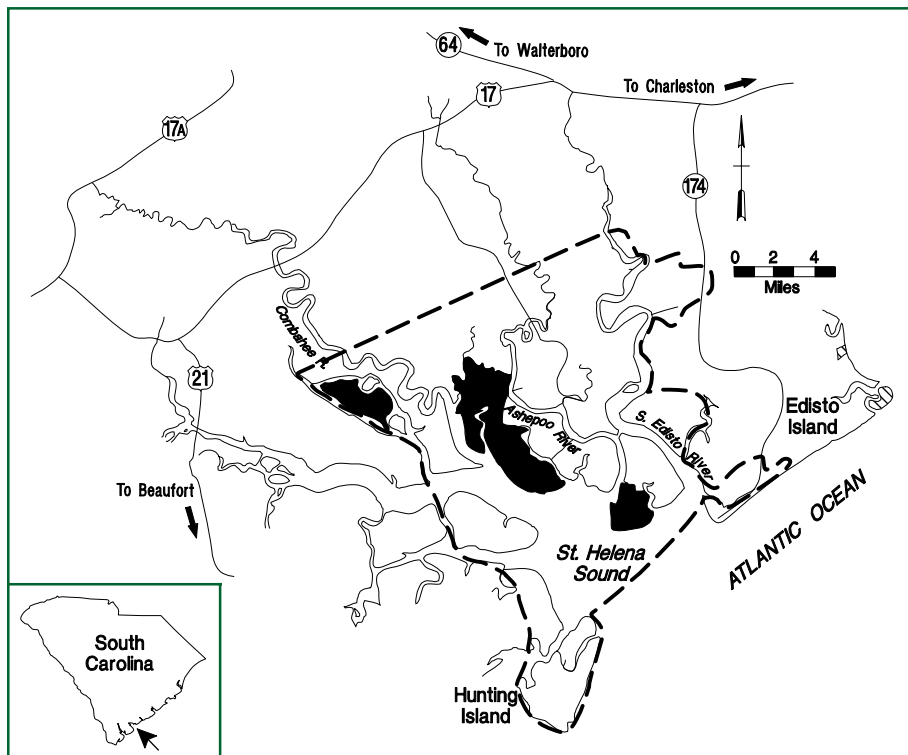
The ACE Basin National Estuarine Research Reserve (NERR), designated in 1992, is the second largest NERR in the nation. The Reserve is managed by the Marine Resources Division of the S.C. Department of Natural Resources. Located approximately 60 miles, southeast of Charleston, it

encompasses over 140,000 acres, of which approximately 60,000 acres constitutes open water, 70,000 acres is covered by salt marsh communities, with the remaining acreage covered by freshwater wetlands and upland communities such as pine forests and maritime forests. The core area is comprised of seven marsh and barrier islands, encompassing over 13,000 acres of wetlands and uplands. The buffer zone is approximately 128,000 acres in size and is characterized by a diverse array of natural and managed communities.

The ACE Basin NERR exhibits tremendous spatial

heterogeneity. From northeast to southwest, the area is divided by the South Edisto, Ashepoo and Combahee Rivers and associated tributaries flowing through extensive wetlands into St. Helena Sound. Habitat diversity, coupled with the absence of industrial pollution and the undeveloped

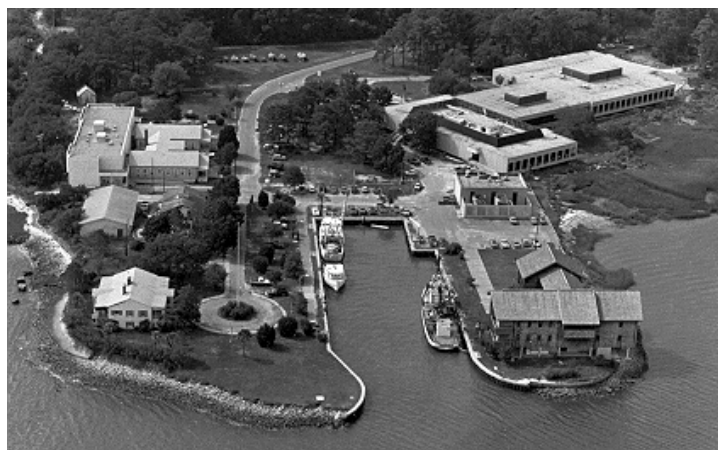
nature of the ACE Basin NERR, contribute to the Reserve's importance to many terrestrial and aquatic species.



The Reserve's complex system of diverse wetland types together with associated upland communities provide habitat for over 260 bird species.

RESEARCH AND MONITORING ACTIVITIES

Facilities to Support Research Efforts



The Marine Resources Center, situated on 75 acres adjacent to Charleston Harbor, is one of the largest marine research and management facilities in the Southeast.

The ACE Basin NERR has recently acquired 2.18 acres with a dock and housing facilities at Bennetts Point to be used for research and housing for visiting scientists. This field station is devoted solely to Reserve activities and supplements existing multiple use facilities at the Marine Resources Center in Charleston, South Carolina which is part of the South Carolina Department of Natural Resources (SCDNR).

The ACE Basin staff interact regularly with scientific staff of other organizations at the Marine Resources Center. The Marine Resources Center houses various SCDNR divisions, including Marine Resources, Water Resources and Land Resources. The Center also provides space for the

University of Charleston's Grice Marine Biological Laboratory, the Medical University of South Carolina's Marine Biomedical Program, the Charleston Laboratory of the National Marine Fisheries Service (NMFS), the U.S. Fish and Wildlife Service (USFWS), and NOAA/USEPA Joint National Coastal Research and Monitoring Program, Carolinian Province office.

Researchers in the Reserve have access to the library at the Marine Resources Division. The library currently receives 389 serial titles and has a cataloged collection of over 50,000 journal

volumes, books and reprints; and maintains an active exchange program with eighty-one partners including foreign and domestic institutions. It is connected to the on-line catalog systems of all university libraries in the United States via the Internet. Reserve staff also have access to the library facilities at the NMFS, USFWS, and the main campus of the University of Charleston.

The computer at the Reserve is linked via a modem to the computer server at MRD. The server provides access to the Internet and E-Mail. Work stations from IBM, SUN Microsystems Inc., as well as Arc Info, ARCVIEW and Erdas image processing software are connected to the server. A network of fiber optics cable links all of the organizations at the Marine Resources Center to the computer server.

Laboratory and office space at Marine Resources Division are also available for scientists to facilitate their research activities in the Reserve. The laboratories of the Marine Resources Research Institute (MRRI) occupy a modern

Biologists study fresh loggerhead turtle tracks on the beach to ascertain whether nesting activities occurred the previous night.



50,000 sq. ft. building and are equipped to analyze nutrients and metals in water, plant and animal tissues, as well as in sediments. The Institute also has culture systems supplied with flow-through and re-circulating seawater, a state-of-the-art graphics center, and photographic darkrooms. A large classroom and a 150-seat auditorium provide ample space for seminars, workshops and meetings.

The Division also maintains a major field station, Waddell Mariculture Research and Development Center, one of the largest aquaculture research facilities in the country. The Center provides space for hatcheries, spawning facilities, support laboratories, offices, dormitory space, and conference facilities for visiting scientists. The extensive pond system is used for controlled research studies as well as for experimental replication, and each pond can be regulated with respect to salinity and water depth.

The Reserve has access to four large research vessels and outboard power boats at the Marine Resources Center through a reservation procedure. There are also outboard power boats at the field station that are available for use on a regular basis.

Management Oriented Research and Other Activities by SCDNR

Wildlife and Freshwater Fisheries Division

The Wildlife Diversity Section performs annual field surveys in the ACE Basin to determine temporal changes in the endangered/threatened species populations. Aerial surveys are done to monitor the nesting efforts of loggerhead turtles, alligators, bald eagles, wood storks, least terns and colonial wading birds. Ground surveys are then conducted to

obtain information about the density of these animals in order to evaluate management needs. In 1994, a Dolphin Count Survey was initiated to ascertain the numbers of bottlenose dolphins that utilize the estuaries of South Carolina; two sites are located within the NERR.

Endangered and threatened natural plant communities are also surveyed by the Wildlife Diversity Section. Between 1983 and 1987, the staff surveyed 2651 Carolina Bays in South Carolina, including twenty in Colleton County where 90% of the Reserve is located. The objectives of the study were to: assess the degree of disturbance in the bays, characterize the ecological and geomorphic conditions in the bays, and identify the least altered and most significant bays for inclusion into the Heritage Trust protection program. Several of the bays in Colleton were determined to be relatively undisturbed, and they have been selected as candidates for acquisition or as listings in the register of the state's Heritage Trust Program.

The Wildlife Management Section conducts annual surveys of game mammals and birds in order to monitor the temporal changes in populations of these species. These data are used to set the closing and opening dates of hunting seasons and to close hunting grounds that are over-harvested. This section also manages Bear Island (in the Reserve) and Donnelly Wildlife Management Areas (borders the Reserve). These areas provide over 20,000 acres of managed habitat (i.e. impoundments and pine plantations) for game and non-game wildlife including threatened and endangered species. These two areas are available for resource management research projects.

Populations of three fish species (flathead catfish, redbreast sunfish and striped bass) that inhabit the limnetic and brackish zones of the ACE Basin are monitored by the Freshwater Fisheries Section. The objectives of these studies are: to determine the distribution and abundance of these species and to assess their food preferences as well as their size and age structures. Striped bass are also tagged

Bear Island WMA consists of managed wetlands, tidal and inland wetlands, forests and food plots that are managed as habitat for migratory and resident game, nongame and endangered species.



Freshwater biologists catch their targetted fish with electrofishing sampling gear, then weigh , measure, and tag before releasing them unharmed to the area of capture.



before release so that biologists can ascertain migration patterns. These data are used to develop management plans for enhancing year class strengths of the redbreast sunfish or controlling populations of the non-native flathead catfish populations. Information about the migration patterns of striped bass helps biologists improve stocking methods of the fish and ascertain variability in genetic stocks.

Water Resources Division

Water Resources Division (WRD) has developed a GIS database that includes information about the natural resources in the ACE Basin watershed. The digital cartographic database was developed using an ARC/INFO geographic information system (GIS) and geo-referenced to 1983 North American Data. The database includes a unique digital data layer (1:24,000 scale) for many natural resources in the watershed, including elevation patterns, geologic formations, soil types, land use/cover types, archeological/historical sites and endangered/threatened species locations. This information will improve the staff's public policy and decision making capabilities regarding natural resource management.

Marine Resources Division

The Office of Fisheries Management (OFM) conducts annual field surveys in coastal waters, including the Reserve, to determine the current population levels of recreational and commercially important aquatic species. Adult populations of shrimp and blue crabs are also monitored on a yearly basis for the purpose of determining the peak migrations of

the organisms from the estuary to offshore. This survey is important in determining the opening and closing dates of the commercial shrimping season.

Tidal creeks are sampled weekly during spring and summer for juvenile shrimp and blue crab. These data are used to determine species composition and distribution, and the growth rates of the species that utilize the tidal creeks. Data are correlated with rainfall, temperature and salinity in order to determine to what extent these physical factors affect the annual migration rate into the estuaries and the growth rates of juveniles in the estuaries.

Staff at the Marine Resources Research Institute (MRRI) conduct research studies in the Reserve that are designed to obtain baseline information on the abundance and distribution of fish, crabs, and shrimp, as well as other biota, in South Carolina estuarine systems. These studies also attempt to

identify and evaluate natural and anthropogenic factors that affect the abundance and distribution of important species.

In 1991, MRD staff collected oysters from estuarine systems in South Carolina, including the nearby North Edisto River system, to determine the prevalence and infection intensity of an oyster pathogen, *Perkinsus marinus* (dermo), in South Carolina. The pathogen was found in over 90% of the oysters sampled, indicating that the incidence of the disease is widespread. The infections were most intense in late summer/early fall and least intense in the winter. There also appears to be a positive correlation between parasitism by *P.*

marinus and water temperature and salinity.

In 1991, MRRI initiated a project to determine life history and population dynamics (temporal and spatial abundance and composition) of selected species of marine recreational fishes in South Carolina. Twelve of the 30 sample sites are located in the Reserve. At those sites, the fishes are counted, measured, weighed and then released. Selected fishes are tagged for auxiliary migration and growth studies.

Between 1991 and 1994, red drum, spotted sea trout and flounder were collected from various estuarine systems in the state, including St. Helena Sound. The livers and fillets were analyzed for contaminants, and the results indicated



Trammel nets are used to collect finfish undamaged for tag and release studies.



Data from the weather station at Bennetts Point are integrated in the National Monitoring Program database.

Management Oriented Research and Activities by Other Agencies

that the chemical contaminant levels were typically lower in filets than in livers. Pesticides were commonly detected in livers, but usually at low levels. The results imply that the level of chemical contamination is low in these important species and were not likely to cause adverse biological effects on the fish; nor did the levels exceed the Food and Drug Administration criteria for human consumption.

In 1993, the Nationwide Comprehensive Estuarine Monitoring and Assessment Program (EMAP) was implemented in the estuaries from North Carolina to the Indian River lagoon in Florida, including three sites in St. Helena Sound estuary. The program is designed to evaluate the status and trends of ecological resources and identifies associations between pollution stress and ecological conditions. A suite of indicators (water quality parameters, sediment characteristics, sediment contaminants, sediment toxicity test, benthic communities, and nektonic assemblages) was measured at the sites. The data were compared in order to distinguish degraded habitats from those that show no adverse signs of anthropogenic impacts. Little to no evidence of elevated sediment contaminants or dissolved oxygen stress was observed at the St. Pierre Creek and Combahee River sites. The third site is in the South Edisto River, that is located within the Atlantic Intracoastal Waterway, was classified as a degraded site.

During the summers of 1990-1992, The Nature Conservancy conducted an extensive biological inventory project within the ACE Basin watershed. The project focused on the identification and classification of natural plant communities. Aerial photo interpretation and aerial reconnaissance were used to identify specific sites, and twelve of the twenty-five sites selected are located in the Reserve. The inventory provides detailed, site-specific information on the occurrence and species composition of natural communities, as well as the documentation of rare plant species in the Reserve.

The Water Quality Section (WQS) of the S.C. Department of Health and Environmental Control monitors surface water and sediment quality in the Ashepoo, Combahee and South Edisto rivers, about 10 miles upstream from the Reserve. Water samples are collected monthly and analyzed for several basic water quality parameters (i.e. salinity, BOD₅, nutrients, solids). Quarterly or annual analyses of water and



Dominant vegetation types mapped in the laboratory are verified through field reconnaissance.

Management Oriented Research and Other Activities by Reserve Staff

sediment samples are done for metals, pesticides, PAHs, volatile and extractable organics. Water quality (salinity, water temperature, fecal coliform) at shellfish beds in the Reserve is tested at least six times during the harvest season.

The U.S. Geological Survey (USGS) collects continuous stream flow data from S. Edisto and Combahee, upstream of the Reserve. Water quality, primarily nutrients and particulates levels, at the flow gauging station are monitored bi-monthly. In May 1995, USGS installed a climate station in the Reserve that is equipped with: soil and air thermometers, a rain gauge, barometer, pyrhelimeter, anemometer and hygrometer. Continuous measurements are relayed to USGS via satellite, and data are available to the Reserve via the Internet.

In September 1992, the U.S. Army Corps of Engineers collected surface sediment samples from four sites along the Atlantic Intracoastal Waterway (AIWW) through the Reserve. The samples were analyzed for dioxins (PCDDs and PCDFs), and the data indicated that the concentrations of these dioxins in the sediments are not at toxic levels.

Personnel at the U.S. Forest Service's Southern Research Station in Charleston, South Carolina are conducting studies in the Donnelly Wildlife Management Area within the ACE Basin. The objectives are: to determine the spatial variation in aboveground production (i.e., stemwood, seed, leaf) of trees across a flooding gradient; and to determine the relationship between productivity and nutrient circulation.

Reserve staff are conducting a long-term survey of the decapod crustaceans and juvenile fish found in the Ashepoo, Combahee and South Edisto Rivers. In each of the rivers, four sampling stations are situated along a salinity gradient, ranging from polyhaline to oligohaline and limnetic. Bottom tows are made against the tide during daylight flood tide; and basic water quality and atmospheric parameters and tidal stage are recorded at each station. Data collected during the fish and decapod survey over the long term will be utilized to assess temporal and spatial changes in species composition, diversity and biomass within the Reserve.

The Reserve staff have initiated a vegetation characterization study to complete the plant survey conducted by The Nature Conservancy (TNC). During 1995 and 1996, plant



Deep sediment cores were collected from the salt marsh on South Hutchinson Island and the subtidal area of the Ashepoo River.

communities on South Williman Island were identified, mapped and characterized. The landscape of South Williman Island is very similar to the marsh islands included in the TNC study. The salt marsh communities encompass over 50% of these islands, and maritime communities dominate the upland terrain. Freshwater wetlands, especially depression meadows and ponds, are scattered throughout the landscape on most of these areas, characterized primarily by grasses and sedges.

In March 1995, Reserve staff began participating in a NOAA/NERRS national coordinated monitoring program, designed to identify and track short-term and long-term variability in each of 22 Reserves over a range of spatial (local, regional, national) and temporal scales. Results of this program contribute to effective national, regional and site-specific coastal zone management. This goal will be accomplished through phased monitoring of three major categories: 1) abiotic (physical-chemical) factors; 2) biological communities; and 3) land/water use. The focus of Phase 1 is on water quality.

Three sites in the Reserve appear to be best suited for studying contrasting hydrographic conditions and land use patterns. Two sites are in the Edisto River drainage basin: one located near the developed Edisto Beach, and the other near undisturbed Bailey Island. The third site is in the Ashepoo River drainage basin, near an impoundment on North Hutchinson Island at Rock Creek. Several water quality parameters (water temperature, dissolved oxygen, pH, specific conductivity and turbidity) are recorded continuously by data loggers. Current data show few indications of major differences in water quality variables between the three sites, but long-term monitoring may reveal some differing trends in water quality as anthropogenic activities increase in the study area.

Other Research Projects Occurring Within ACE Basin NERR

In 1994, a NOAA/NERRS funded study was conducted to compare the impacts of chromated copper arsenate (CCA) - treated wood on the surrounding benthic communities in the Reserve. The objective of this study was to determine to what degree and over what distances benthic fauna may be adversely affected by contaminants. The data indicated no

significant differences in contaminant levels or biotic community structure between the two sites. Thus, it appears that metal leachates from the pilings, even the new ones, have negligible ecological effects in reasonably flushed areas like the Reserve. Drs. Judith and Peddrick Weis at Rutgers University at Newark were the principal investigators.

In 1994, the ACE Basin NERR and National Marine Fisheries Services (NMFS) staff initiated a three-year study to assess the distribution of contaminants (trace metals, PAHs, pesticides) in surface sediments within the major rivers of the Reserve. The 1994 and 1995 data indicated that trace metal and PAH concentrations in the sediments did not contain toxic concentrations of either. However, the data suggested that the areas within and downstream of the Atlantic Intracoastal Waterway have the most degraded sediments in the Reserve. Dr. Geoff Scott at National Marine Fisheries and Dr. Tom Mathews at Marine Resources Division are the principal investigators.

In 1995, ACE Basin NERR and S.C. Sea Grant Consortium jointly funded a study to determine the historical input of contaminants to the Reserve. Radiochemical profiles of the sediment cores indicate that the subtidal sediments accumu-

late rapidly (>5 cm/month) and episodically, whereas the intertidal sediments accumulate at a slower (0.42 cm/month) rate. Long-term metal profiles show that concentrations in the sediments have increased with time, and historical metal profiles demonstrate that fluxes of metals to the Reserve have increased by 1.5-3 x over the last century. These results indicate an increase in anthropogenic loading to the Reserve, and nickel has the strongest anthropogenic signal at the study site. Dr. Clark Alexander at Skidaway Institute of Oceanography and Dr. Elizabeth Wenner at Marine Resources Division were the principal

investigators.

During 1995 and 1996, NOAA Coastal Services Center and Marine Resources Division developed a PC-based desktop mapping and analysis prototype for evaluating and addressing management issues based on interactive access to ecological characterization data linked with other digital information. The prototype revolves around a real-time management scenario on Otter Island and the surrounding



Horseshoe crabs begin their spawning activities in late March/early April, and peak spawning activities occur during new and full moon.

area. The characterization draws upon existing ecological and socioeconomic data for the Otter Island area to assess natural resource values, ecologically sensitive areas, man's impact on the area, and proposed regulations for long-term protection and management of the island. The prototype CD-ROM product is currently available from the NOAA Coastal Services Center in Charleston.

In April 1996, a survey of horseshoe crabs on Otter, Pine and Harbor islands was initiated. The primary objectives of the study are: to identify critical spawning habitat, to document temporal spawning activities, and to estimate magnitude of spawning activities within spawning areas.

Research-Education Coordination Activities

Information produced by research efforts is integrated into the Reserve's education program that includes educational cruises, nature walks, and teacher workshops. In addition, staff sponsor a seminar series for citizens and the general public. The seminars cover a variety of environmental and marine resource issues, including the status/management of South Carolina's natural resources, natural history of marine and terrestrial animals, as well as panel discussions on environmental problems facing coastal South Carolina.

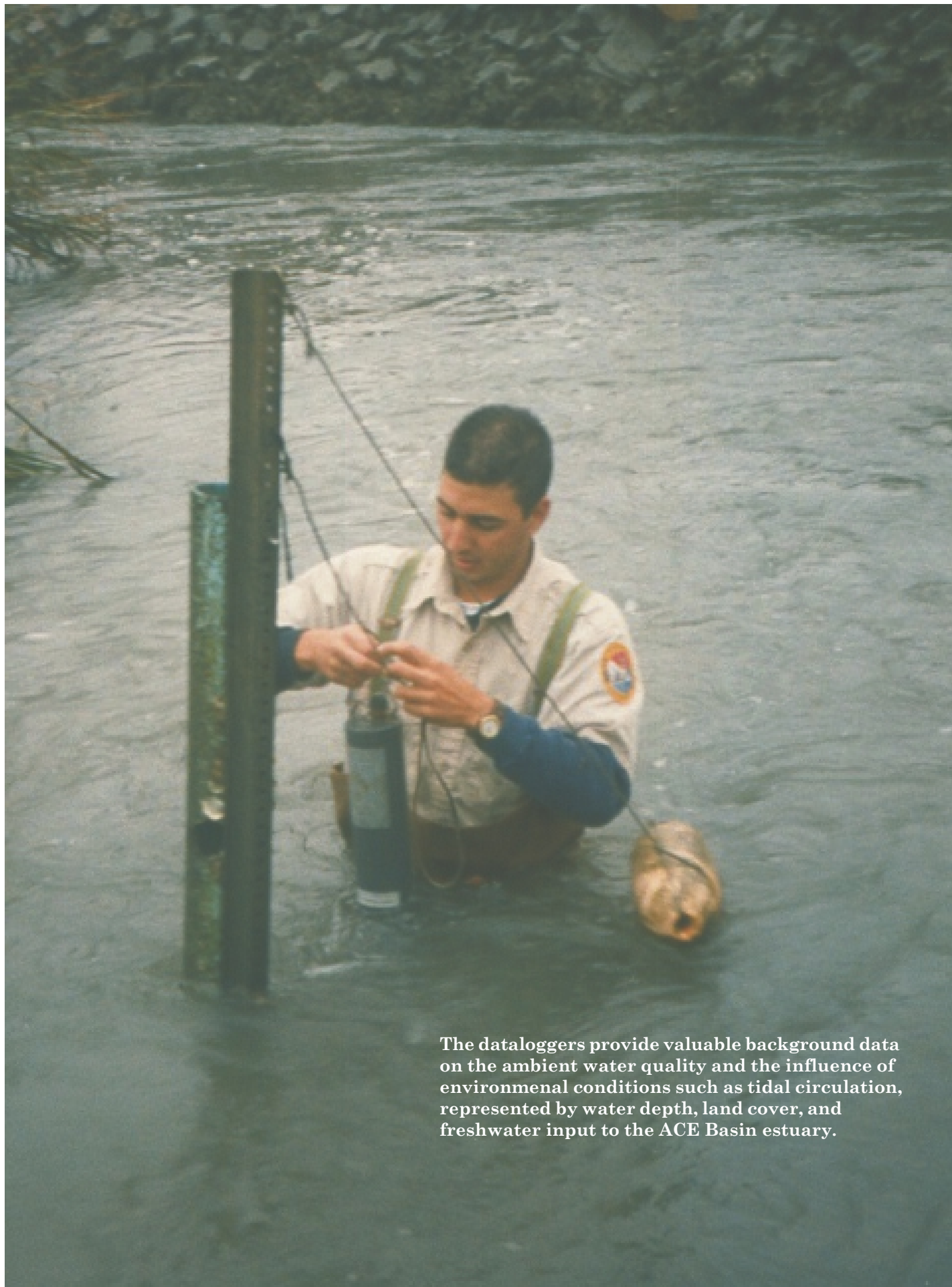
Sources of Funding

The National Estuarine Research Reserve System (NERRS) has a new program of Graduate Research Fellowships that is designed for students interested in conducting management oriented research projects in one or more of the 22 reserves. The projects must address management issues, including but not limited to non-point source pollution,

estuarine ecosystem restoration and sustainable growth in estuarine ecosystems. The NERRS provides up to 42 competitive Graduate Research Fellowships each year. Funding is available to students for up to three years, and the annual stipend is \$15,000. Applicants are encouraged to contact the Research Coordinator for the ACE Basin NERR to discuss proposal ideas.



The Reserve offers a wide variety of educational programs that provide a "hands-on" look at coastal habitats, such as the estuarine community.



The dataloggers provide valuable background data on the ambient water quality and the influence of environmental conditions such as tidal circulation, represented by water depth, land cover, and freshwater input to the ACE Basin estuary.



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